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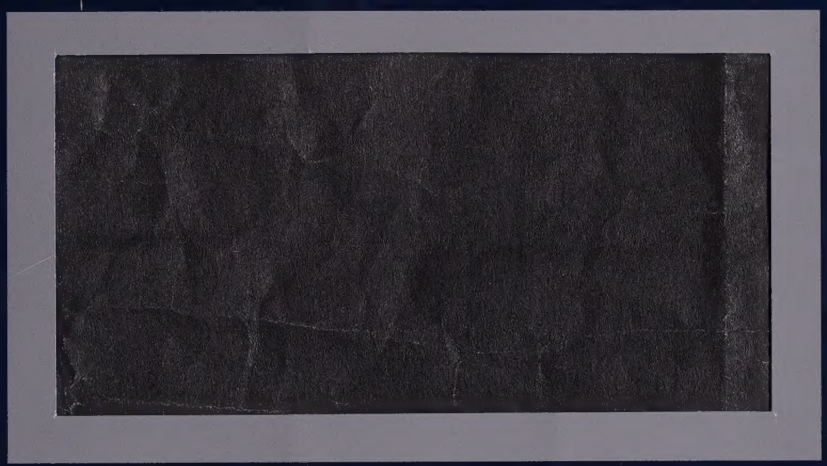

Operating Manual

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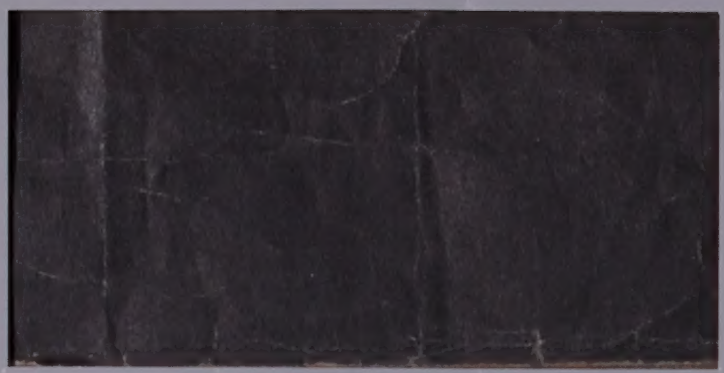

50-11924-01
Rev. A

T1/E1 TEST ACCESS INTERFACE (MODEL 41900) OPERATING MANUAL

DECEMBER 1993

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20400 Observation Drive
Germantown, Maryland 20876
(800) 638-2049 • (301) 353-1550 (MD) • FAX (301) 353-9216
WWW Address: http://www.ttc.com

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SECTION 1 GENERAL INFORMATION

1.1 INTRODUCTION

This manual contains the Test Access Interface (Model 41900) description, setup, operating instructions, specifications, and service information.

1.2 INTERFACE OVERVIEW

The Test Access Interface is used with a FIREBERD, an ISU (Interface Switching Unit), and either a T1 or El data interface. Functioning as a miniature switch, the Test Access Interface is well suited for testing at the mid-span of a T1 or E1 circuit. Figure 1-1 shows a typical equipment connection with a FIREBERD and Test Access Interface as integral parts of a Test Access System. A Test Access System provides centralized and remotely controlled access to T1 or E1 links at a DCC (Digital Cross-Connect).

Using a controller, the operator can remotely configure the Test Access Interface to monitor the East CSU (Channel Service Unit) or West CSU, terminate toward the East or West CSU, or test the entire span (round robin). When the FIREBERD and Test Access Interface are connected to a pair of test access ports of a Test Access System, the operator selects the circuit to be monitored or tested and then configures the Test Access Interface to support the test to be performed. Configuration of the Test Access Interface can be performed at the front panel or from a remote terminal.

Combining its mid-span monitoring/testing capabilities with the remote control capability, the Test Access Interface provides a powerful tool for comprehensive centralized testing.

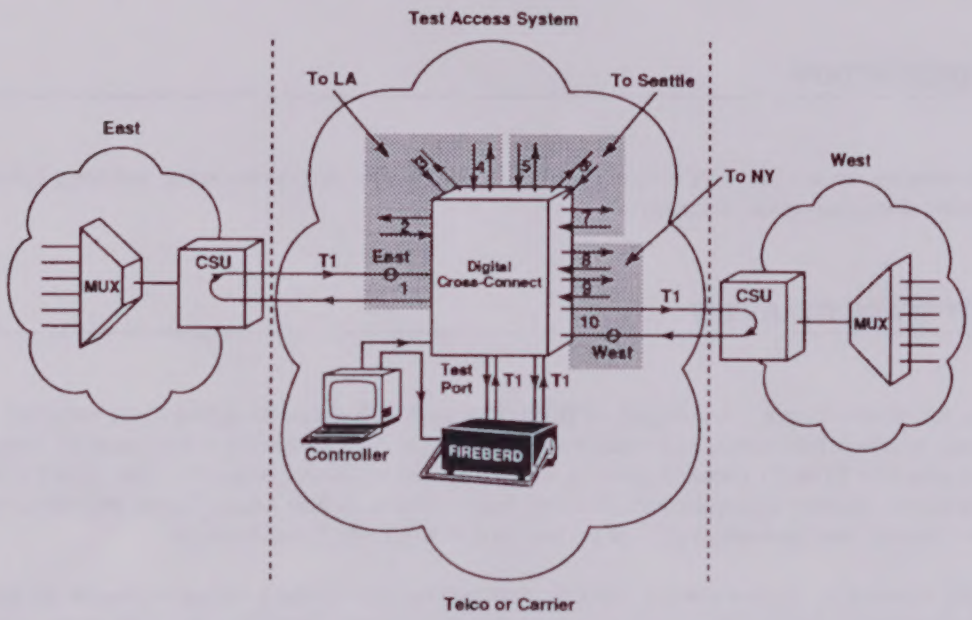

Figure 1-1. The Test Access interface Connected to a Test Access System

1.3 INTERFACE FEATURES

The Test Access Interface has the following features.

Three port connectors are provided: two ports, one for each direction (east and west) of a span; the third port for routing the selected connection to an external FIREBERD interface for error analysis.

Routes the east or west receive jack to the test port for monitoring the span in the east or west direction.

Routes and terminates the transmit/receive pair from the east or west direction to the test port for testing the span toward the east or west direction.

Routes the transmit from the east and the receive from the west (or vice versa) to the test port allowing complete testing (round robin) of the span.

Front panel or remote control.

1.4 EQUIPMENT SUPPLIED

The Test Access Interface, Model 41900, consists of:

- Test Access Interface (Model 41900)
- Model 31054 Bantam plug-to-15-pin D-type connector, (18") or
  Model 31053 Siemens 3-pin plug-to-15-pin D-type connector, (18")
- 50-11924-01 Test Access Interface Operating Manual

1.5 OPTIONS AND ACCESSORIES

Since the Test Access interface also requires either a T1 or E1 interface, the following equipment configurations are possible:

1. FIREBERD 6000, ISU, Test Access Interface, and T1 or E1 interface.
2. FIREBERD4000, ISU, Test Access Interface, and T1 or E1 interface.
3. FIREBERD 4000 (with second interface slot Option 4001), Test Access Interface, and T1or E1 interface.

The following equipment and cables are available from TTC for use with the Test Access Interface.

- ISU 6000-4 Interface Switching Unit (4 interface slots)
- ISU 6000-8 Interface Switching Unit (8 interface slots)
- Model 41440 T1/FT1 Interface
- Model 40540 DS1/T1/D4/ESF/SLC-96 Interface
- Model 30609 CCITT G.704 2048 kb/s Interface
- 30503 Bantam plug-to- 15-pin D-type male connector (IO')

SECTION 2 INTERFACE DESCRIPTION

2.1 INTRODUCTION

This section contains the Test Access Interface physical description, functional description, and the port connectors pin assignments.

2.1.1 Physical Description

The Test Access Interface, illustrated in Figure 2-1, is installed into one of the interface slots of an ISU and a T1 or E1 interface is installed into another ISU slot. The ISU ribbon cable is then inserted into the FIREBERD 6000 or FIREBERD 4000 interface slot. If a FIREBERD 4000 is equipped with a second interface slot (Option 4001), the ISU is not necessary.

Three 15-pin, D-type connectors are located on the interface front panel. These connectors are labeled: WEST, EAST, and TEST. The WEST connector connects to the west direction of the T1 or E1 span. The EAST connector connects to the east direction of the T1 or E1 span. The TEST connector routes the received signal to an external interface, either T1 or E1, for analysis.

Once connected to the T1 or E1 span, the interface maybe set to pass signals to the FIREBERD for analysis or to pass the signal through the interface without interruption.

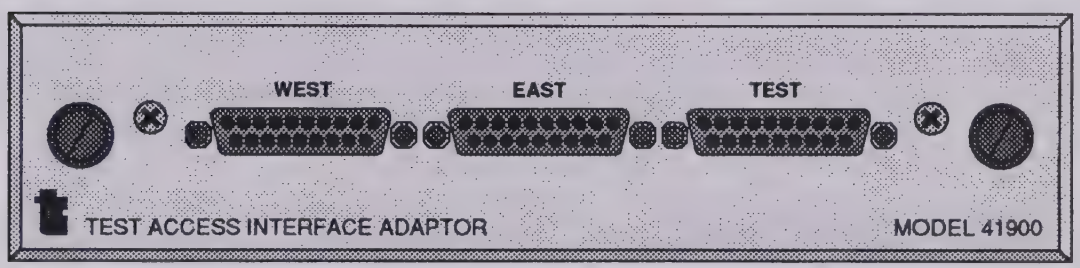

Figure 2-1. Model 41900 Test Access Interface

The Test Access interface connector pin assignments are listed in Table 2-1. The connector signals listed in Table 2-1 are for normal (NORM) operation. When the connection menu item is set to reverse (REV), the direction (e.g., transmit and receive) is reversed. Reverse can be used to correct for a cross-connected wiring error.

Table 2-1. Test Access Interface Connector Pin Assignments

Connector	Pin	Signal
WEST	1	West Tx Tip
	2	Signal Ground
	3	West Rx Tip
	4	Signal Ground
	9	West Tx Ring
	11	West Rx Ring
	All other pins are unconnected	
EAST	1	East Tx Tip
	2	Signal Ground
	3	East Rx Tip
	4	Signal Ground
	9	East Tx Ring
	11	East Rx Ring
	All other pins are unconnected	
TEST	1	Test Tx Tip
	2	Signal Ground
	3	Test Rx Tip
	4	Signal Ground
	9	Test Tx Ring
	11	Test Rx Ring
	All other pins are unconnected	

2.2 FUNCTIONAL DESCRIPTION

The Test Access Interface can be operated in one of three configurations (monitor, test, or round robin), in two directions (east or west), resulting in six operating modes. These six operating modes permit the Test Access Interface to: test toward the east CSU, test toward the west CSU, monitor signals from the east CSU, monitor signals from the west CSU, or test the span end-to-end toward the east, with loopbacks at each CSU (round robin) or test the span end-to-end toward the west. The round robin direction can only be specified for software revision H FIREBERD 6000s and revision 5 FIREBERD 4000s. The following figures (Figure 2-2 to Figure 2-4) are examples of the three configurations of the Test Access Interface. Table 2-2 lists the six operating modes for the three interface configurations when the CONNECTION menu is set to normal (NORM). Refer to Figure 3-5 and Figure 3-8 for the FIREBERD 6000 and FIREBERD 4000 Test Access Interface menus. The transmit (Tx) and receive (Rx) designations in Table 2-2 indicate the T1 or E1 connector of the external interface to which the signal is applied. The E (east) or W (west) designation indicates the direction of the signal at the TEST port.

Table 2-2. Configuration Controlled Receive and Transmit Direction

Configuration	Tx	Rx
Monitor East	—	E
Monitor West	—	W
Test East	E	E
Test West	W	W
Round Robin East	E	W
Round Robin West	W	E

Whether monitoring or testing, there are four major steps to be performed:

1. Select and configure the Test Access Interface.
2. Select and configure the T1 or E1 interface.
3. Configure the FIREBERD mainframe (e.g., generator clock, test pattern, etc.) for the test to be run.
4. Observe the analysis results.

Figure 2-2 illustrates the monitor west mode. In the monitor mode, the receive pair of the T1/E1 signal for the selected direction is passed through the Test Access Interface and the FIREBERD without disrupting the circuit. The signal is only monitored. Monitor selections are: Monitor East or Monitor West. The monitor mode sectionalizes the circuit and monitors received data on half of the span at a time. By selecting the opposite direction, east, the other half of the span can be monitored.

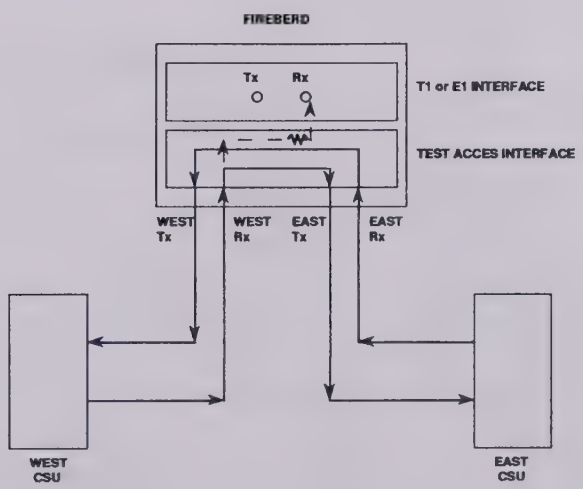

Figure 2-2. Monitor Mode

Figure 2-3 illustrates the test east mode. In the test mode, the T1/E1 signal is taken out of service and the CSU, either east or west, can be tested by setting it in loopback with the FIREBERD. The FIREBERD transmits a test pattern and analyzes the received signal for errors. The test mode sectionalizes the circuit and tests half of the span at a time. By selecting the opposite direction, west, the other half of the span can be tested.

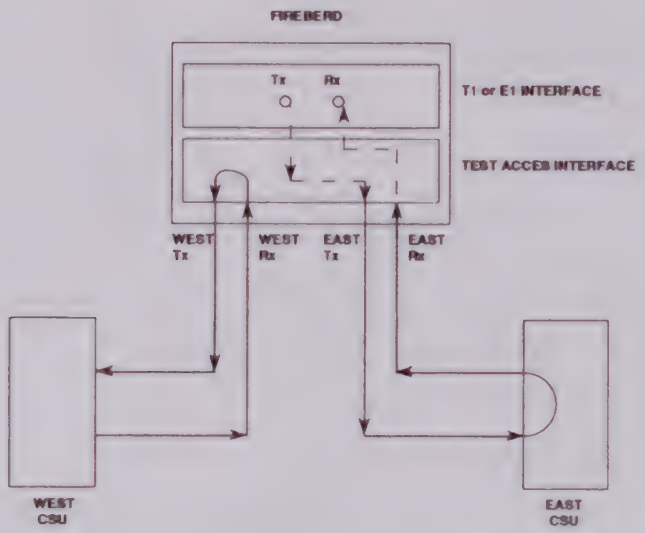

Figure 2-3. Test Mode

Figure 2-4 illustrates the round robin west mode. In the round robin mode, the FIREBERD loops back both the east and west CSUs. The FIREBERD then transmits a test pattern across the whole span and analyzes the received signal for errors. Data transmitted in one direction is looped back through the interface to the CSU in the opposite direction and looped back to the FIREBERD for analysis.

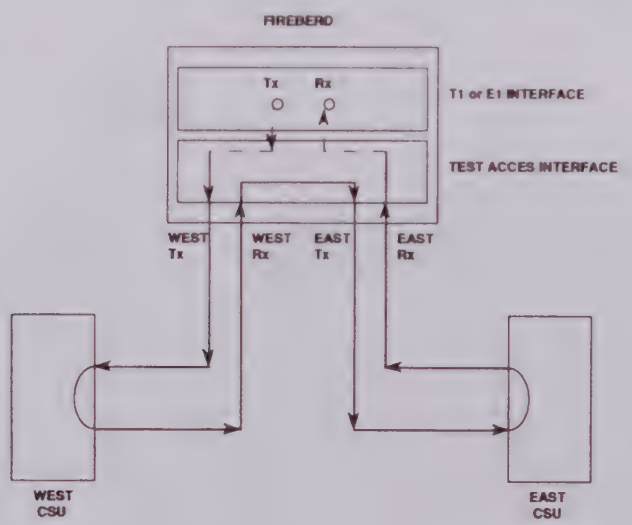

Figure 2-4. Round Robin Mode

In addition to the test modes previously listed, the Test Access Interface can be used with a Test Access System, as illustrated in Figure 2-5. When used with a Test Access System, a controller selects the circuit to be tested and controls the Test Access Interface in the FIREBERD. This configuration permits any circuit connected to the Test Access System to be monitored or tested remotely by using the controller.

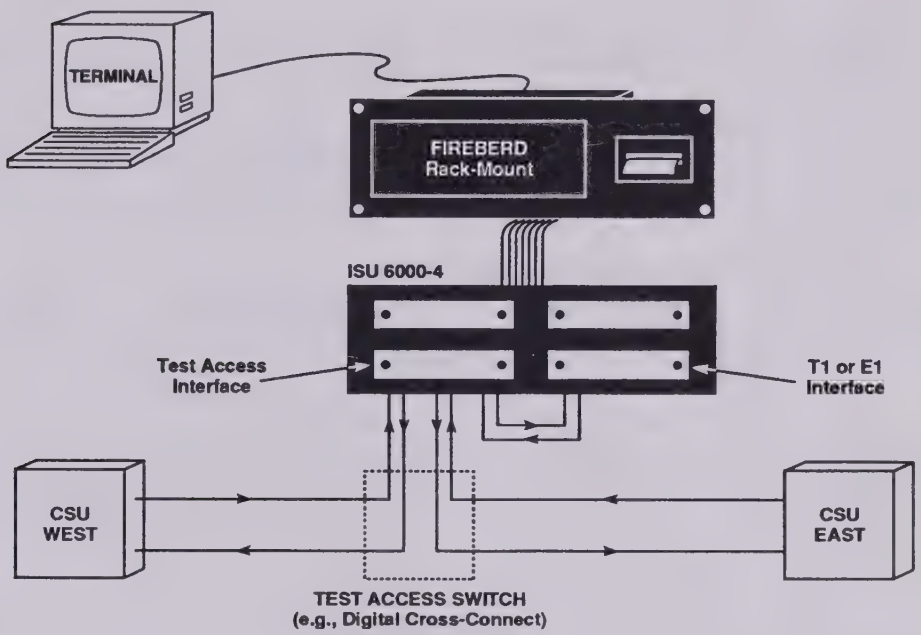

Figure 2-5. Test Access System Mode

SECTION 3 OPERATION

3.1 INTRODUCTION

This section describes local and remote operation of the Test Access Interface with a FIREBERD 6000 and an ISU or with a FIREBERD 4000 that has the second interface slot installed (Option 4001).

It is important to understand that the FIREBERD software revision level installed determines the interface menus displayed and also determines the remote commands used to control the Test Access Interface. A jumper wire (JW1), located on the Test Access Interface printed circuit board, is set according to the software revision level installed in the FIREBERD mainframe.

The mainframe software revision level determines the remote control command syntax. Software Rev. E, and F, equipped units use standard IEEE-488 (1987), while software Rev. G, and later, equipped units use IEEE-488.2 syntax. To accommodate the differences in syntax, a jumper wire, located on the printed circuit board, is used to configure the Test Access Interface for use with the different software revision levels.

For FIREBERD 6000s with software Rev. G or for FIREBERD 4000s with software Rev. 4, or lower revisions for each mainframe, set the jumper wire between pins 1 and 2 as shown in Figure 3-1. For FIREBERD 6000s with Rev. H or for FIREBERD 4000s with software Rev. 5 set the jumper wire between pins 2 and 3 as shown in Figure 3-2.

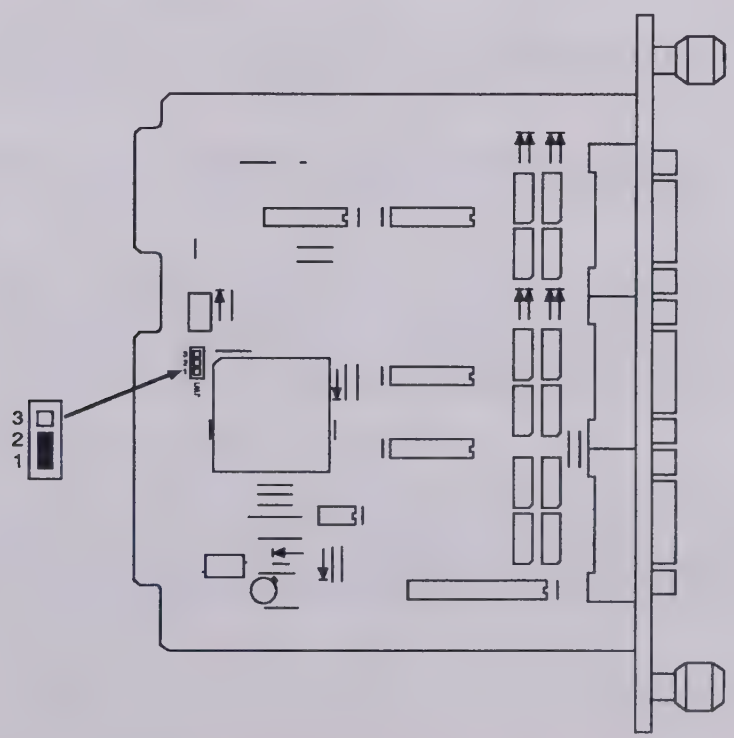

Figure 3-1. Jumper Wire Position for Software Rev. G or Rev. 4, or earlier, Equipped FIREBERDs

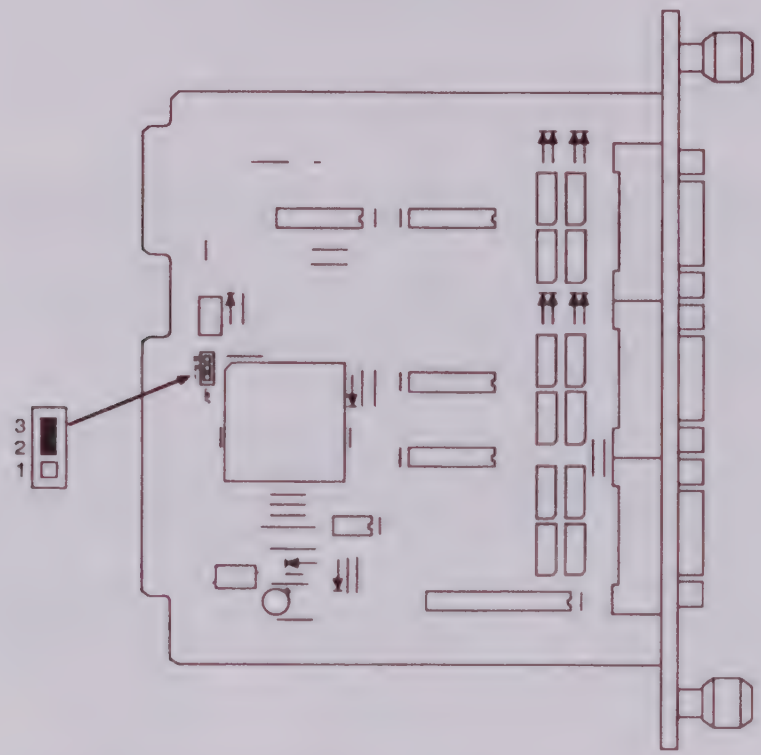

Figure 3-2. Jumper Wire Position Software for Rev. H or Rev. 5 Equipped FIREBERDS

3.2 FIREBERD 6000 LOCAL OPERATION WITH THE TEST ACCESS INTERFACE

The FIREBERD 6000 software revision level determines the Test Access Interface menus displayed and the remote control syntax. Figure 3-4 shows the menus displayed for the Test Access Interface for FIREBERD 6000s with software Rev. G or earlier. In these units the DSOA/B Interface menus are used for the Test Access Interface. However, Figure 3-5 shows the Test Access Interface menus for software revision level H equipped FIREBERD 6000s. Rev. H equipped FIREBERD 6000s directly support the Test Access Interface operation.

Figure 3-3 illustrates a typical equipment connection for the FIREBERD 6000 and ISU. This configuration allows the FIREBERD 6000 Data Communications Analyzer to be used to monitor or test toward the east CSU or toward the west CSU. With the Test Access Interface installed in an ISU that is connected to a FIREBERD 6000, perform the following steps to select the Test Access Interface as the active interface. Figure3-4 illustrates the Test Access Interface menu for FIREBERD 6000s equipped with Rev. G, or earlier, software.

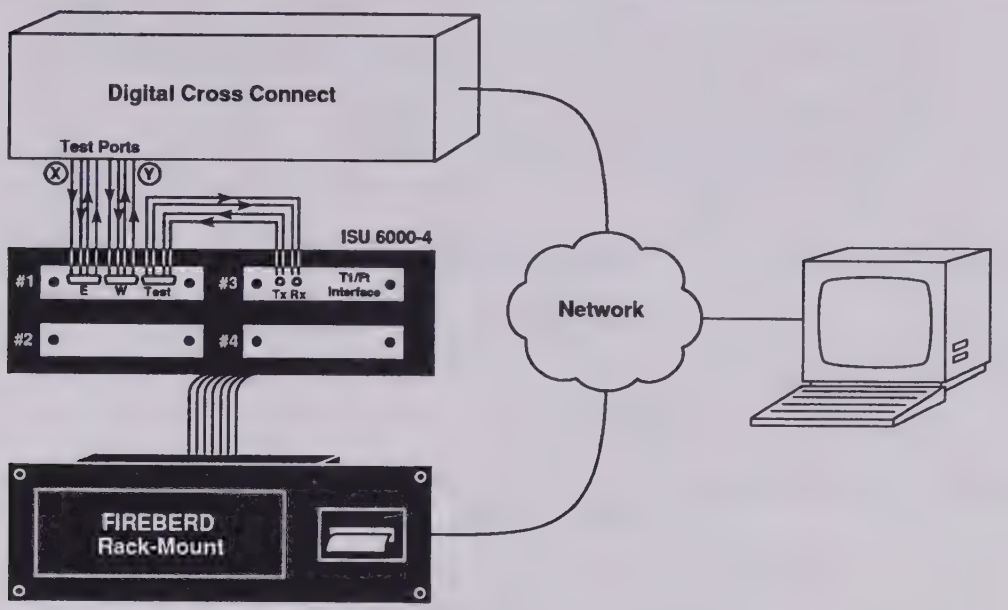

Figure 3-3. Test Access Interface (Model 41900) Equipment Connections

3.2.1 Test Access Interface Operation For Rev. E, Rev. F, or Rev. G Equipped FIREBERD 6000s

The following steps describe the procedure for selecting the Test Access Interface when installed in an ISU and used with software Rev. E, Rev. F, or Rev. G equipped FIREBERD 6000s.

Step **Procedure**

1. Press the MENU switch to illuminate the LED next to the INTF SETUP label.
2. Press the softkey below the ISU menu item.
3. Press the softkey below the slot menu item (S1, S2, S3, or S4) that contains the Test Access Interface.
4. In FIREBERD 6000s equipped with Rev. G, or earlier, software selecting the Test Access Interface displays: **DSOA/B**. This is displayed because complete support of the Test Access Interface is not available until Rev. H software.
   A. Press the softkey below the DSOA/B menu item.
   B. Press the softkey below the MODE menu item.
   C. Press the softkey below the DSOA menu item.
   D. Press the softkey below the RATE softkey to select the desired configuration. The data rates translate to the following test configurations:
      2.4 = Monitor East
      4.8 = Monitor West
      9.6 = Test East
      19.2 = Test West
      56 = Round Robin
5. Press the up arrow key to return to the INTF SETUP top level menu.

6. Press the softkey below the ISU menu item and select the interface slot for the T1 or E1 interface to be used. Once the T1 or E1 interface is selected, set the interface menu selections as required.
7. Scroll through the selected interface menu to view the TERM (termination) menu selection.
8. Set the interface termination according to the test being performed as follows:

   Test - TERM
   Monitor - DSX MON
   Round Robin - TERM

9. Press the GEN CLOCK switch to illuminate the LED next to the SYNTH (synthesizer) label.

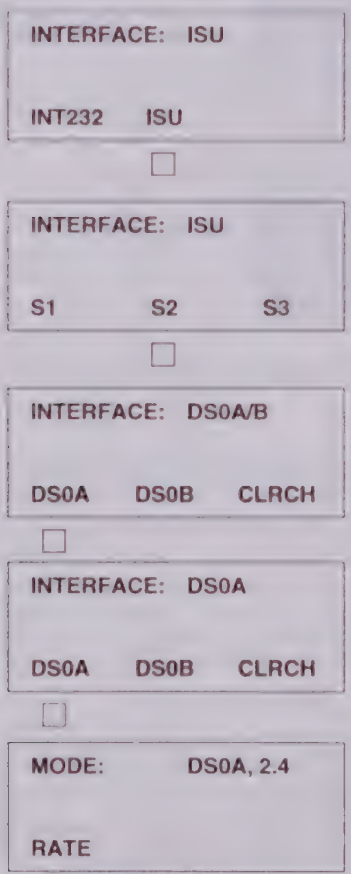

Figure 3-4. Test Access Interface Menu for Software Rev. E, F, and G Equipped FIREBERD 6000s

3.2.2 Test Access Interface Operation for Rev. H Equipped FIREBERD 6000s

The following steps describe the procedure for selecting the Test Access Interface when installed in an ISU and used with software Rev. H equipped FIREBERD 6000s.

With the Test Access Interface installed in an ISU and the ISU connected to the FIREBERD 6000, perform the following steps to establish it as the selected interface. Figure 3-5 illustrates the Test Access Interface menu for Rev. H equipped FIREBERD 6000 mainframes.

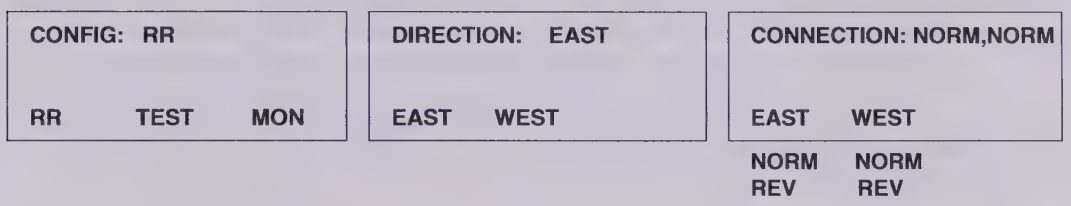

Figure 3-5. Test Access Interface Menu for Software Rev. H Equipped FIREBERD 6000s

Step	Procedure

1. Press the MENU switch to illuminate the LED next to the INTF SETUP label.
2. Press the softkey below the ISU menu item.
3. Press the softkey below the slot menu item that the Test Access Interface is installed in.
4. With Rev. H software installed, selecting the Test Access Interface displays **ACCESS** on the top line and three menu item selections (**CONFIG**, **DIRECT**, and **CON**) on the bottom line.
5. Press the softkey below the CONFIG (configuration) menu item to select the test configuration. Configuration choices are:

   RR - Round Robin: Tests the span from end-to-end.
   EAST - Test Mode: Terminates and tests the span in the direction selected.
   MON - Monitor Mode: Monitors the span in the direction selected.

6. Press the softkey below the DIRECT (direction) menu item to select the direction the selected configuration is monitoring/testing. Direction choices are:

   EAST - Monitors/tests toward the east
   WEST - Monitors/tests toward the west

7. Press the softkey below the CON (connection) menu item to select the connector orientation. Changing the connector receive and transmit orientation may be performed if the circuit tested has a reversed connection. Connection choices are:

   NORM - Rx and Tx directions are as listed in Table 2-2.
   REV - Reverses the Tx and Rx directions listed in Table 2-2.

8. Press the up arrow key to return to the INTF SETUP top level menu.
9. Press the softkey below the ISU menu item and select the interface slot for the T1 or E1 interface to be used. Once the T1 or E1 interface is selected, set the interface menu selections as required.
10. Scroll through the selected interface menu to view the TERM (termination) menu selection.
11. Set the interface termination according to the test being performed as follows:

    Test - TERM
    Monitor - DSX MON
    Round Robin - TERM

3.3 FIREBERD 4000 LOCAL OPERATION WITH THE TEST ACCESS INTERFACE

The FIREBERD 4000 software revision level determines the Test Access Interface menus displayed and the remote control commands used. With software revision level 4 installed, the Test Access Interface uses the DSOA/B Interface menus, but FIREBERD 4000s equipped with software revision level 5 directly support the Test Access Interface.

Figure 3-6 illustrates a common equipment connection for the FIREBERD 4000. This configuration allows the FIREBERD 4000 Data Communications Analyzer to be used to monitor or test the CSU east link, the CSU west link, or the east to west CSU link. With the Test Access Interface installed in an ISU, perform the following steps to establish it as the selected interface. Figure 3-7 illustrates the Test Access Interface menu for software Rev. 4 equipped FIREBERD 4000 mainframes and Figure 3-8 illustrates the Test Access Interface menu for software Rev. 5 equipped FIREBERD 4000s. If the FIREBERD 4000 has two interface slots (Option 4001), the ISU is not required.

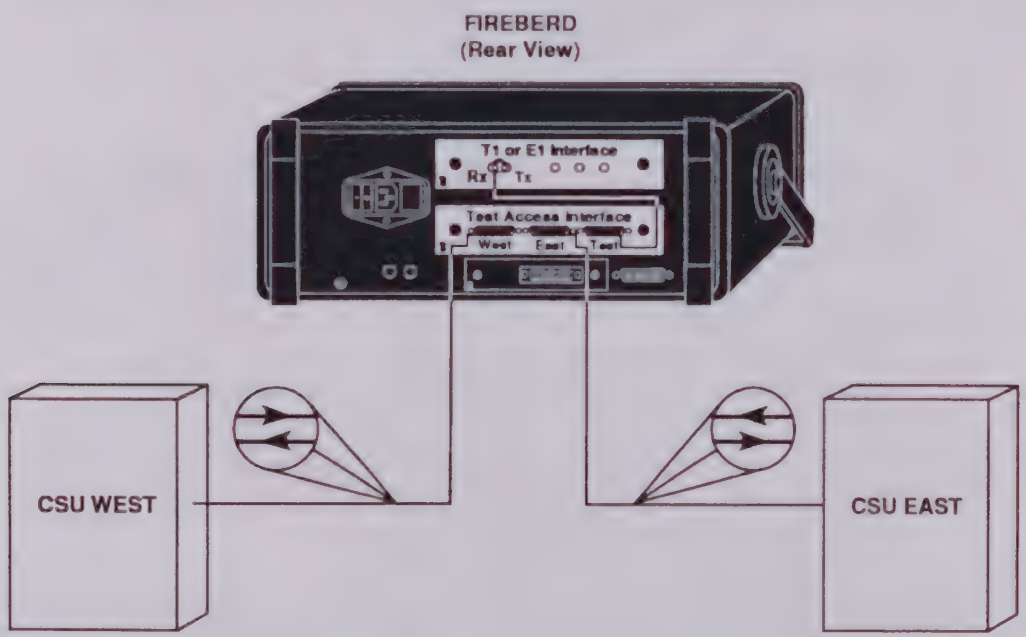

Figure 3-6. Test Access Interface (Model 41900) Equipment Connections

3.3.1 Test Access Interface Operation for Rev. 4 Equipped FIREBERD 4000s

The following steps describe the procedure for selecting the Test Access Interface when installed in an ISU and used with software Rev. 4 equipped FIREBERD 4000s.

Step **Procedure**

1. Press the CATEGORY switch to illuminate the LED next to the INTERFACE label.
2. Press the softkey below the DSOA/B menu item to select the Test Access Interface.
3. With Rev. 4 software, selecting the Test Access Interface displays: **DSOA/B**. This is displayed because complete support of the Test Access Interface is not available until Rev. 5 software.
   A. Press the right arrow on the SETUP SELECT switch to display the MODE menu.
   B. Press the right arrow on the SETUP SELECT switch to display the DSOA menu.
   C. Press the softkey below the RATE softkey to select the desired configuration. The data rates translate to the following test configurations:
      2.4 = Monitor East
      4.8 = Monitor West
      9.6 = Test East
      19.2 = Test West
      56 = Round Robin
4. Press the up HOME switch to return to the INTF SETUP top level menu.
5. Press the softkey below the T1 or E1 menu item and select that interface as the interface to be used.
6. Scroll through the selected interface menu to view the TERM (termination) menu selection.
7. Set the interface termination according to the test being performed as follows:
   Test - TERM
   Monitor - DSX MON
   Round Robin - TERM
8. Press the CATEGORY switch to illuminate the LED next to the GENERATOR CLOCK label and select the SYNTH (synthesizer) menu item.

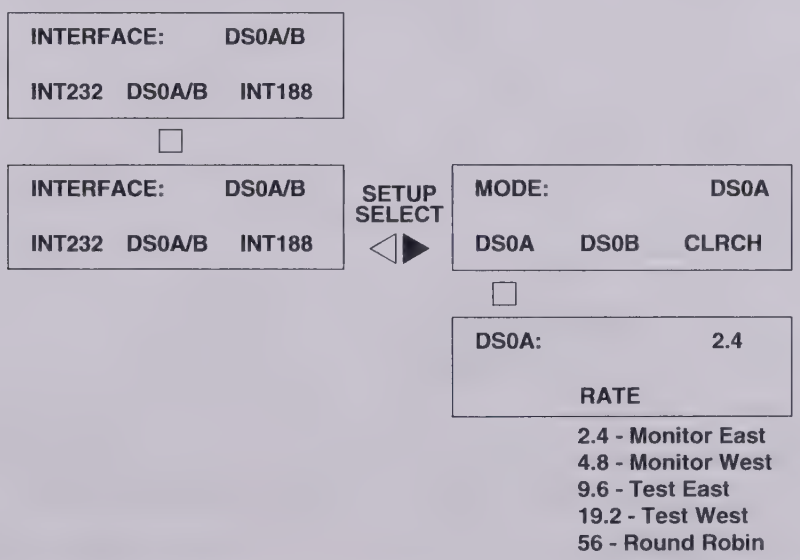

Figure 3-7. Test Access Interface Menu For Software Rev. 4 Equipped FIREBERD 4000s

3.3.2 Test Access Interface Operation For Rev. 5 Equipped FIREBERD 4000s

The following steps describe the procedure for selecting the Test Access Interface when installed in an ISU and used with software Rev. 5 equipped FIREBERD 4000s.

With the Test Access Interface installed in a FIREBERD 4000, perform the following steps to establish it as the selected interface.Figure 3-8 illustrates the Test Access Interface menu for software Rev. 5 equipped FIREBERD 4000 mainframes.

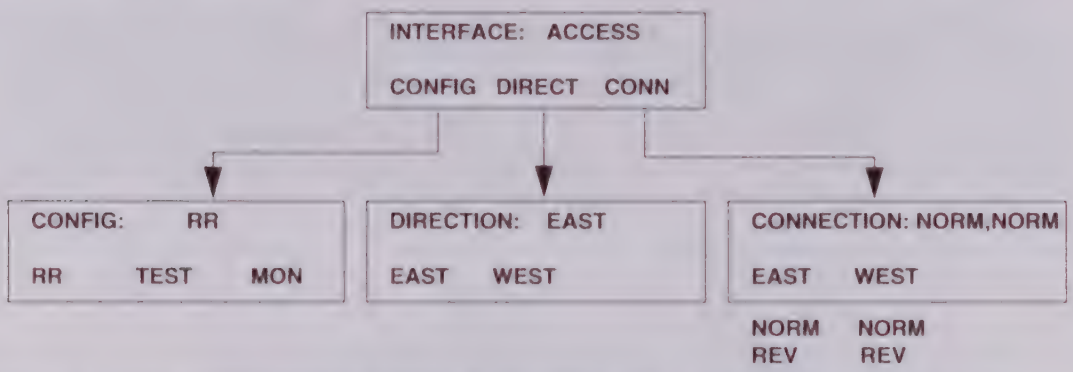

Figure 3-8. Test Access Interface Menu For Software Rev. 5 Equipped FIREBERD 4000s

Step **Procedure**

1. Press the CATEGORY switch to illuminate the LED next to the INTERFACE label.
2. Press the softkey below the ACCESS menu item.
3. Press the right arrow on the SETUP SELECT switch to display the configuration menu.
4. Press the softkey below the CONFIG (configuration) menu item to select the test configuration. Configuration choices are:

   RR - Round Robin: Tests the span from end-to-end.
   TEST - Test Mode: Terminates and tests the span in the direction selected.
   MON - Monitor Mode: Monitors the span in the direction selected.

5. Press the softkey below the DIRECTION menu item to select the direction the selected configuration is monitoring/ testing. Direction choices are:

   EAST - Monitors/tests toward the east
   WEST - Monitors/tests toward the west

6. Press the softkey below the CONNECTION menu item to select the connector orientation. Connection choices are:

   NORM - Rx and Tx directions are as listed in Table 2-2.
   REV - Reverses the Tx and Rx directions listed in Table 2-2.

7. Press the HOME switch to return to the INTERFACE top level menu.
8. Press the softkey below the T1 or E1 menu item and select the interface to be used.
9. Scroll through the selected interface menu to view the TERM (termination) menu selection.
10. Set the interface termination according to the test being performed as follows:

    Test - TERM
    Monitor - DS X MON
    Round Robin - TERM

3.4 FIREBERD REMOTE OPERATION WITH THE TEST ACCESS INTERFACE

Remote operation of the Test Access Interface requires a FIREBERD mainframe, an ISU, and a suitable remote controller, such as a PC, a terminal, or a controller. Remote control of the FIREBERD is initiated by sending a valid remote control command.

Depending on the software revision level installed determines the remote control commands sent and the syntax used for the commands. There are three versions of remote commands that can control the operation of the Test Access Interface. FIREBERD 6000s with software Rev. E, F, and FIREBERD 4000s with software Rev. 4 are supported by one version of remote commands. FIREBERD 6000s with software Rev. G are supported by another version of remote commands. And FIREBERD 6000s with software Rev. H and FIREBERD 4000s with software Rev. 5 are both supported by another version of remote commands.

The remote control commands and syntax supported by the different revisions of software are listed in the following paragraphs.

The following commands are for use with FIREBERD 6000s equipped with software Rev.E, F, or FIREBERD 4000s equipped with software Rev. 4, or lower.

INT SEL DSOA/B	Selects the Test Access Interface.
ISU X	Selects the interface in ISU slot X (where X = 1- 4).
GEN CLK SYN	Selects the internal synthesizer as the generator clock timing source.
INT SET DSOA/B MOD DSO RAT 2.4K	Selects Monitor East as the Test Access Interface configuration.
INT SET DSOA/B MOD DSO RAT 4.8K	Selects Monitor West as the Test Access Interface configuration.
INT SET DSOA/B MOD DSO RAT 9.6K	Selects Test East as the Test Access Interface configuration.
INT SET DSOA/B MOD DSO RAT 19.2K	Selects Test West as the Test Access Interface configuration.
INT SET DSOA/B MOD DSO RAT 56K	Selects Round Robin as the Test Access Interface configuration.

The following commands are for use with FIREBERD 6000s equipped with software Rev. G. This version of software supports the IEEE-488.2 syntax.

INTF:SELECT:DSOA-B	Selects the Test Access Interface.
INTF:SELECT:ISU X,X	Selects the ISU X (where X = 1 or 2) and the interface in ISU slot X (where X = 1- 4).
CONFIG:GEN-CLK SYNTH	Selects the internal synthesizer as the generator clock timing source.
INTF:SELECT DSOA-B:DSOA 2.4	Selects Monitor East as the Test Access Interface configuration.
INTF:SELECT DSOA-B:DSOA 4.8	Selects Monitor West as the Test Access Interface configuration.
INTF:SELECT DSOA-B:DSOA 9.6	Selects Test East as the Test Access Interface configuration.

INTF:SELECT DSOA-B:DSOA 19.2	Selects Test West as the Test Access Interface configuration.
INTF:SELECT DSOA-B:DSOA 56	Selects Round Robin as the Test Access Interface configuration.

The following commands are for use with FIREBERD 6000s equipped with software Rev. H or FIREBERD 4000s equipped with software Rev. 5.

INTF:ACCESS:CONFIG RR	Selects Round Robin as the Test Access Interface configuration.
INTF:ACCESS:CONFIG TEST	Selects Test as the Test Access Interface configuration.
INTF:ACCESS:CONFIG MON	Selects Monitor as the Test Access Interface configuration.
INTF:ACCESS:DIRECTION EAST	Selects East as the direction.
INTF:ACCESS:DIRECTION WEST	Selects West as the direction.
INTF:ACCESS:CONNECTION:EAST NORMAL	Selects Normal for the east connection.
INTF:ACCESS:CONNECTION:EAST REVERSE	Selects Reverse for the east connection.
INTF:ACCESS:CONNECTION:WEST NORMAL	Selects Normal for the west connection.
INTF:ACCESS:CONNECTION:WEST REVERSE	Selects Reverse for the west connection.

SECTION 4 MAINTENANCE AND SERVICE

4.1 INTRODUCTION

This section contains information on maintenance and service procedures for the Test Access Interface. TTC's warranty policy and repair procedures are also described in this section.

4.2 MAINTENANCE

4.2.1 In Case of Difficulty

If the interface fails to operate and no front panel indicators illuminate, check the following:

- AC power cord and AC power supply of FIREBERD and ISU.
- AC fuses and fuse rating.

If some of the indicators illuminate but the unit fails to operate, verify that the interface in use is properly inserted in the mainframe (turn power off before removing or inserting the interface). Check the interface and/or mainframe cabling and connections to verify proper connection. Substituting a known good interface is recommended, if one is available.

If problems still persist, follow the self-test procedures described in the FIREBERD Operating Manual to aid in localizing the problem. If the unit continues to be inoperative, refer to the following paragraphs for servicing information or call TTC's Technical Assistance Center for applications assistance.

4.3 SERVICE

4.3.1 Warranty Policy

All equipment manufactured by Telecommunications Techniques Corporation is warranted against defects in material and workmanship. This warranty applies only to the original purchaser and is non-transferable, unless express written authorization is granted by TTC for a warranty transfer.

Liability under this warranty extends only to the replacement value of the equipment. The warranty is void if:

1. The equipment has been altered or repaired without specific authorization from TTC.
2. The equipment is installed or operated in a manner other than those contained in TTC literature and operating manuals.

No other warranty is expressed or implied. TTC is not liable for consequential damages.

4.3.2 In-Warranty Service

Equipment that is in warranty must be returned to the factory with shipping prepaid. The equipment should be packed and shipped in accordance with the instructions in Section 4.3.4 of this manual. Before returning any equipment, the customer must obtain a RA (return authorization) number by contacting the TTC Repair Department. The RA number should then appear on all paperwork and be clearly marked on the outside of the shipping container.

After the equipment is repaired by TTC, it will be tested to applicable specifications, burned-in for at least 24 hours, retested, and returned to the customer with shipping prepaid. A brief description of work performed and materials used will be provided on the equipment repair form that is furnished with the returned equipment.

4.3.3 Out-of-Warranty Service

The procedure for repairing out-of-warranty equipment is the same as is used for in-warranty equipment. However, there is a minimum charge applied to each request for out-of-warranty service. This minimum charge guarantees the customer an estimate of the repair costs and is used as credit against actual materials and labor costs should the equipment be repaired. Contact TTC's Repair Department for specific information on the minimum out-of-service repair charge.

The customer will be billed for parts, plus standard labor rate in effect at the time of repair. The customer will also be required to furnish a purchase order number before repair work is started, and a hard copy of the purchase order must be received by TTC before the repaired equipment is shipped to the customer. A description of the labor and materials used is provided in the equipment repair report.

Once an out-of-warranty repair is made, the repaired part or component is warranted for 90 days. This warranty applies only to the part or component that was repaired. Other parts or components are not covered under this 90-day warranty.

4.3.4 Equipment Return Instructions

The customer should attach a tag on all equipment that is returned to TTC for repair. This tag should include the following information:

1. Customer's name and address.
2. A list of all equipment being returned and the corresponding serial number(s), if applicable.
3. A detailed description of the problem or service requested.
4. The name and telephone number of the person to contact regarding questions about the requested repair.
5. The RA number issued by TTC's Repair Department.

If possible, the customer should return the equipment using the original shipping container and material; providing that it is in good condition. If the original container is not available, the unit should be carefully packed to ensure that it will not be damaged in transit. TTC is not liable for any damage incurred during shipment. The customer should clearly mark the TTC-issued RA number on the outside of the shipping container and ship it prepaid and insured to TTC.

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Telecommunications Techniques Corporation®
20400 Observation Drive, Germantown, Maryland 20876
Tel. (800) 638-2049 or (301) 353-1550 (MD) FAX (301) 353-0731
WWW Address: http://www.ttc.com